Liquidity, Runs, and Security Design: Lessons from the Collapse of the Auction Rate Municipal Bond Market

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Introduction

Current financial turmoil started in the Summer of 2007

- Increasing subprime mortgage defaults triggered an overall reassessment of credit risk
  - especially on structured finance products
- Liquidity dried up as investors pulled back risk-taking
- Short-term credit markets have been hit the hardest
  - A classical bank run on Northern Rock, UK
  - Asset-backed commercial paper shrank considerably
  - The market for auction rate securities (ARS) collapsed
    - Auction failures surged in mid-February
    - Interest costs shot up

Why Do We Care About ARS?

A new angle to broader issues on financial innovations, liquidity fragility, and systemic risks

- Comprehensive documentation on what exactly happened
- The role of investors and broker-dealer in the crisis: runs, contagion, panic
- Vulnerability of security designs
- Origin of systemic risks: Information-based or self-fulfilling panic

ARS also important for municipal bond markets

- High interest rates triggered by auction failures put considerable strains on financial conditions of municipalities
- Affected investors' liquidity and issuers' funding capacity

Main Results

- During the transition period in the mid-February:
  - A "bank-run" type behavior occurred
  - A significant portion of the auction failures cannot be explained by fundamentals
  - Coordination failures occurred
    - An unexpected first mover triggered a simultaneous withdraw of liquidity support by all major broker-dealers
- After the transition period, all else equal:
  - Auctions more likely (80 percentage) to fail with floating maximum rates
  - Among bonds with floating maximum rates, failure probability falls 32 percentage when maximum rate increases by one standard deviation.
  - As predicted by auction theory, there is strong evidence for underpricing
    - Reset rates only weakly related to fundamentals,
    - positively related to maximum rate,
    - higher for bonds with fixed maximum rates,
    - positively related to inter-auction secondary market liquidity

Main Contributions

- New evidence on the existence and the origin of coordination failures and liquidity runs
  - Previous empirical works have focused on runs in depositary institutions and in currency crises (e.g., Calomiris and Mason (2003))
  - Shed lights on the role of inherent vulnerability of new financial products to systemic liquidity shocks
- New evidence to the literature on uniform-price auctions (e.g., Wilson (1979), Back and Zender (1993))
  - Most existing empirical studies on uniform-price auctions examine either the Treasury auctions or auctions on initial public offering of equities
- A comprehensive study of the ARS market
  - Existing studies on ARS are limited
  - Alderson, Brown, and Lummer (1987, FM), Winkler and Flanigan (1991, JFR), Alderson and Frase (1993, FM)

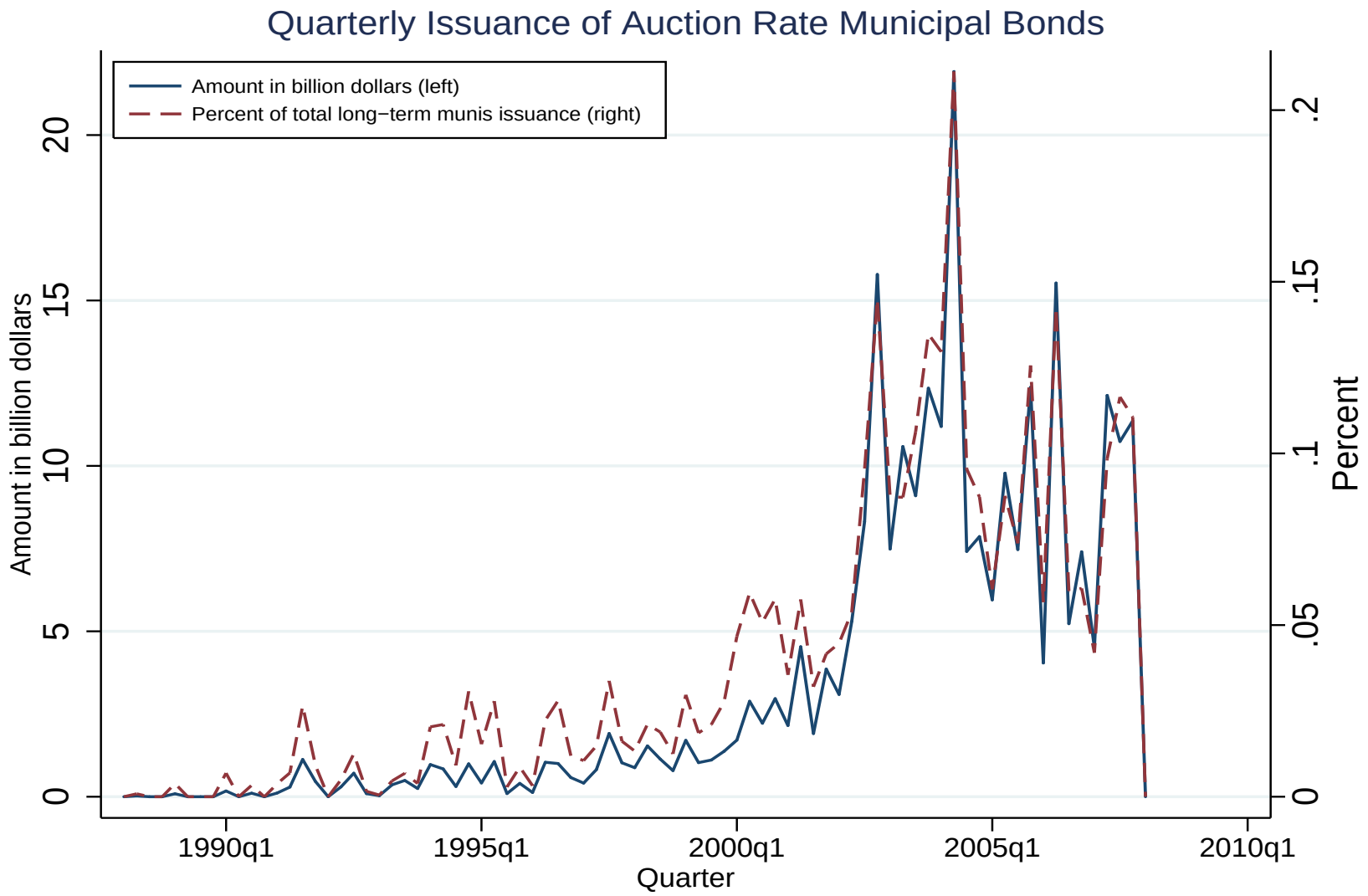
Outline

- What Are ARS?
  - Brief history
  - Auction procedure
- Data and sampling
- Empirical analysis
  - Auction failures: determinants, runs
  - The role of broker-dealer: coordination failure
  - Testing underpricing
- Conclusions: Lessons learned

What Are ARS?

- Auction rate securities (ARS) are long-term securities whose interest rates are reset through regularly scheduled auctions typically every 7, 28, or 35 days.
- Types of ARS:
  - Municipal ARS or MARS: issued by municipalities or student-loan authorities
  - Non-municipal student loan ARS
  - Auction rate preferred stocks (ARPS): issued by corporations or closed-end mutual funds
  - As of Dec. 31, 2007, total ARS was about $330 billion, roughly half of which is accounted for by MARS.
- Invention of ARS:
  - The first is an ARPS, invented in 1984 as an improvement upon adjustable-rate preferred stock
    - Better price discovery
    - Greater liquidity for holders
  - The first MARS was offered in 1988

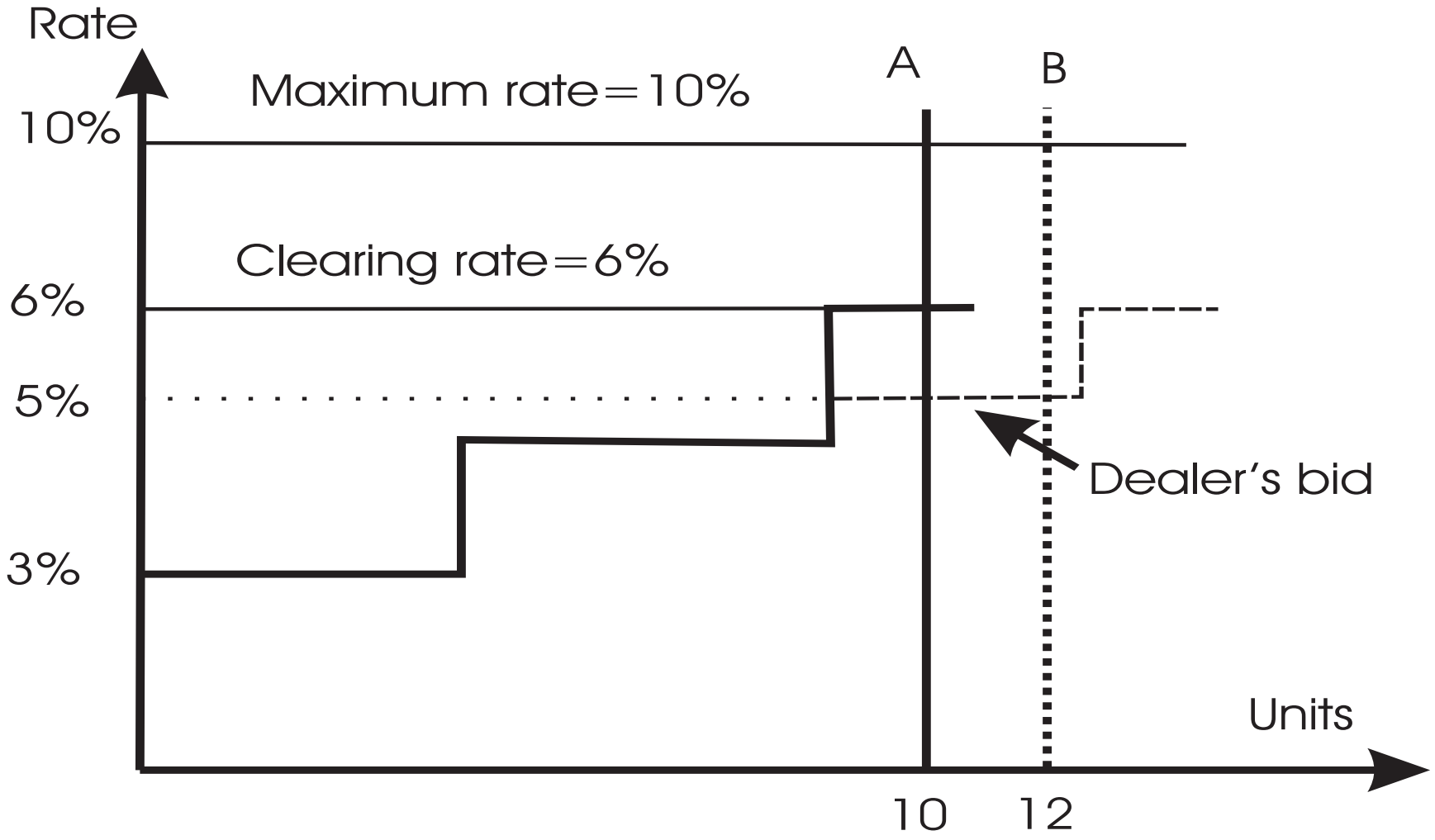
Figure 1: Issuance of MARS



Auction Procedure

- Types of orders by current holders:
  - Hold: hold unconditionally
  - Hold at rate: conditional, both a sell and a buy
  - Sell: unconditional
- Potential holders
  - Buy: limited orders
- All orders are submitted to broker-dealers
- Broker-dealers actions:
  - Bid to support auctions with insufficient demand
  - Can also bid for its own investment purposes
- Auction agent determines outcomes: reset rates and allocations

Figure 2: The Auction Procedure



Data and Sampling

- Data on auction results from three auction agents
  - Auction status, reset rates, benchmark index rate
  - No information on sell and bid orders
- MSRB's RTRS: Intraday transactions data on munis
  - Trade size and price with direction of trade
  - We use trades on auction dates to estimate auction orders
    - Rule G-14, (a)(ii)(B): "a dealer effecting trades in ... auction rate products ... shall report such trades by the end of the RTRS Business Day on which the trades were executed."
  - Reconstruct the dynamics of dealer's inventory
  - Examine the effect of non-auction secondary market on auctions

Data: Continued

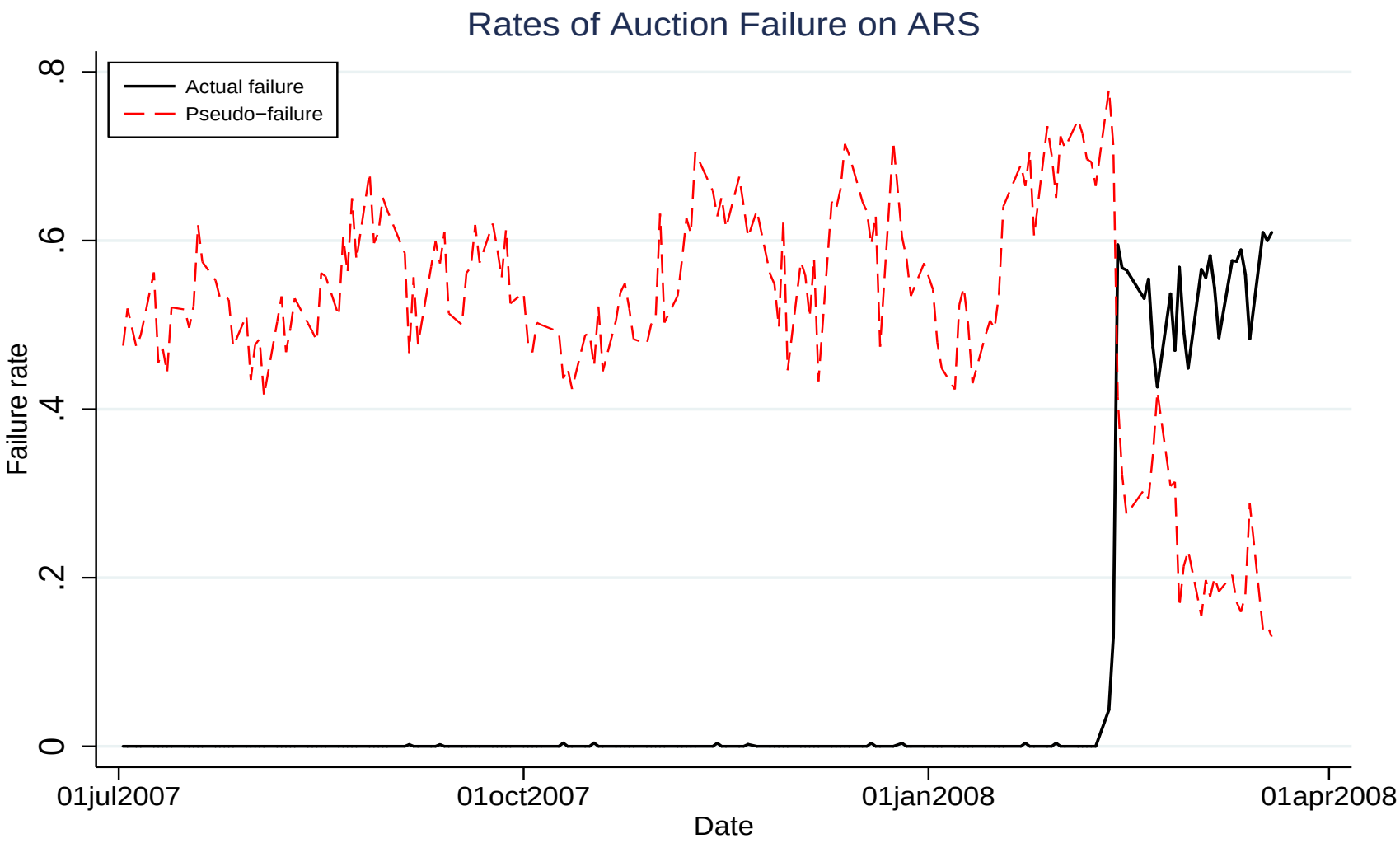
- Data on bond characteristics
  - Identify the rules determining maximum rates based on statistical method and manually collected information
  - Four types of rules:
    - Type A: fixed. E.g., 15 %
    - Type B: multiple. E.g., $\min(\theta \times \text{CP}, 15\ \%)$
    - Type C: markup. E.g., $\min(d + \text{CP}, 15\ \%)$
    - Type D: complex rule. E.g.,

$$\min(\theta \times \text{CP}, N(d + \text{avg. T-Bill}) - (N-1) \times \text{avg. ARS}), 15\ \%)$$

Sample Construction

Sampling	N. of bonds
1. All ARS from WT, BNYM, and DB	4945
2. Appeared at least once in MSRB's RTRS data	3709
3. Merge Bloomberg bond description data	3567
4. Reset frequencies $[7, 35]$ days	3526
Maximum rate rules identified	2755
Type A: Fixed	1159
Type B: multiple	1317
Type C: markup	131
Type D: complex	148

Auction Failure Rates and Pseudo-Failure Rates

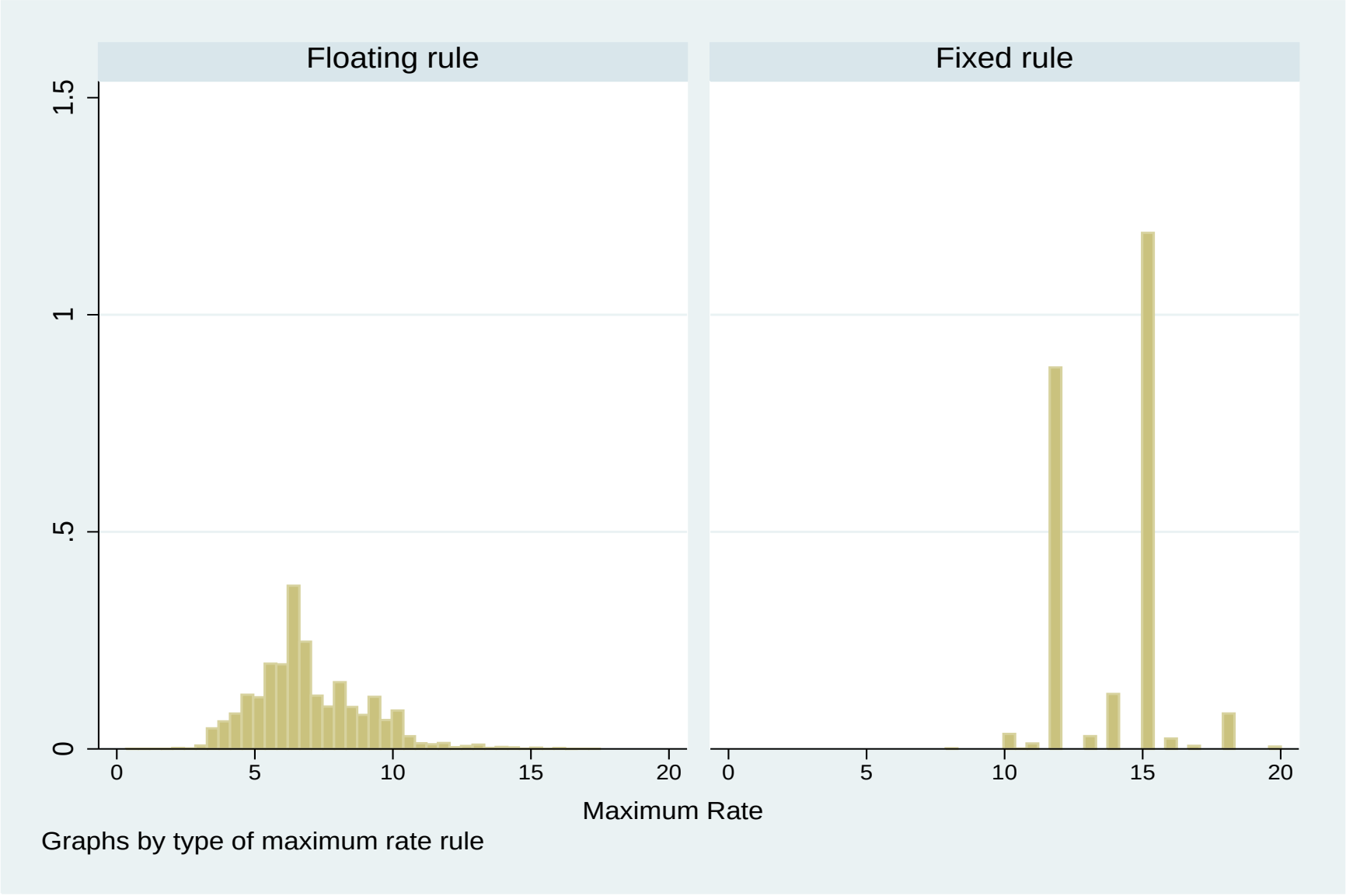


Note. Based on data from three major auction agents

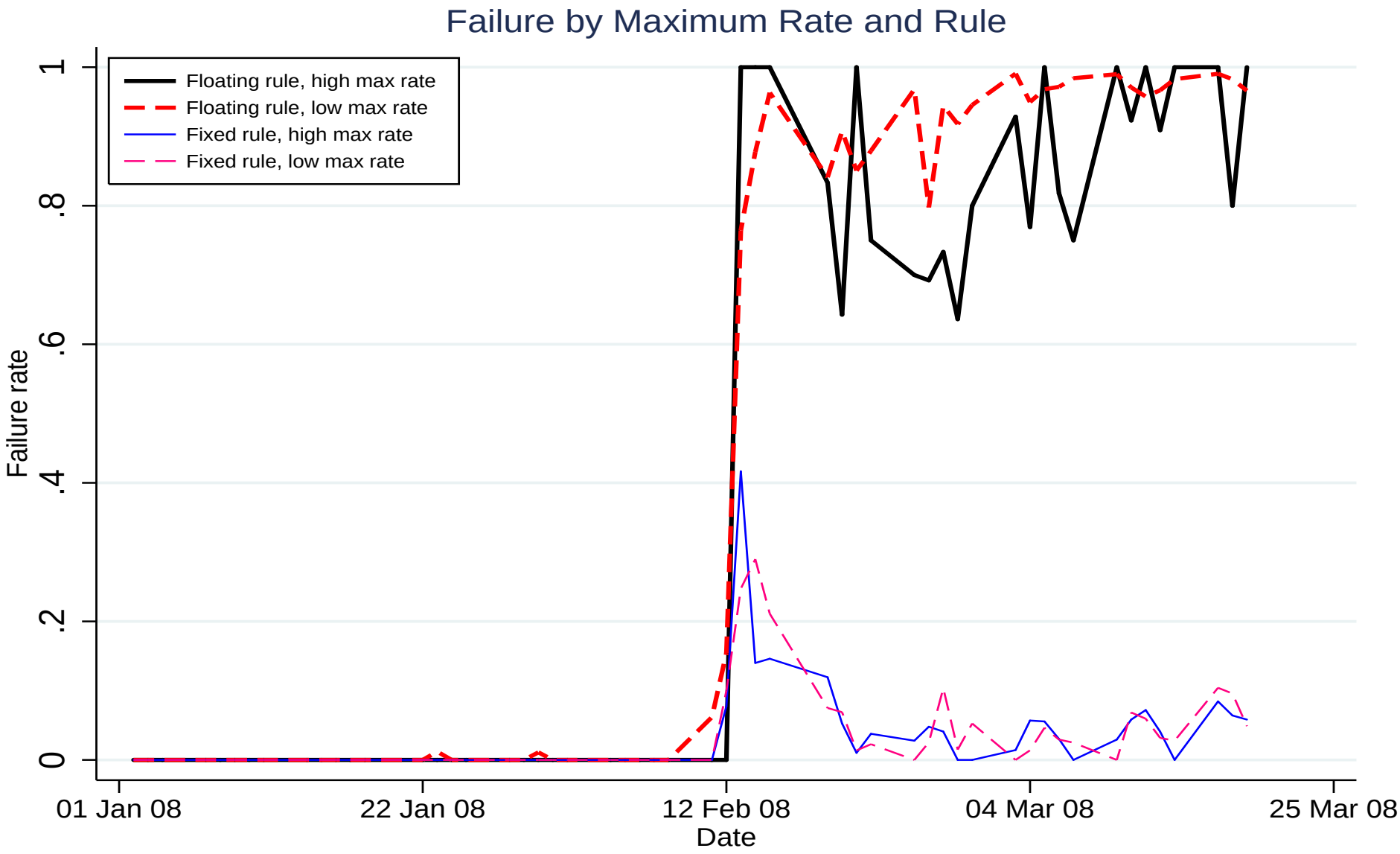
Determinants of Auction Failures

- Auction theory: equilibrium exists if max rate $\geq$ upper support of fundamental value
- Fundamentals matter: bond characteristics, credit risk, macro factors
- Max rate matters: level, uncertainty (fixed/floating)

Distribution of Maximum Rate



Auction Failure Rates by Maximum Rate

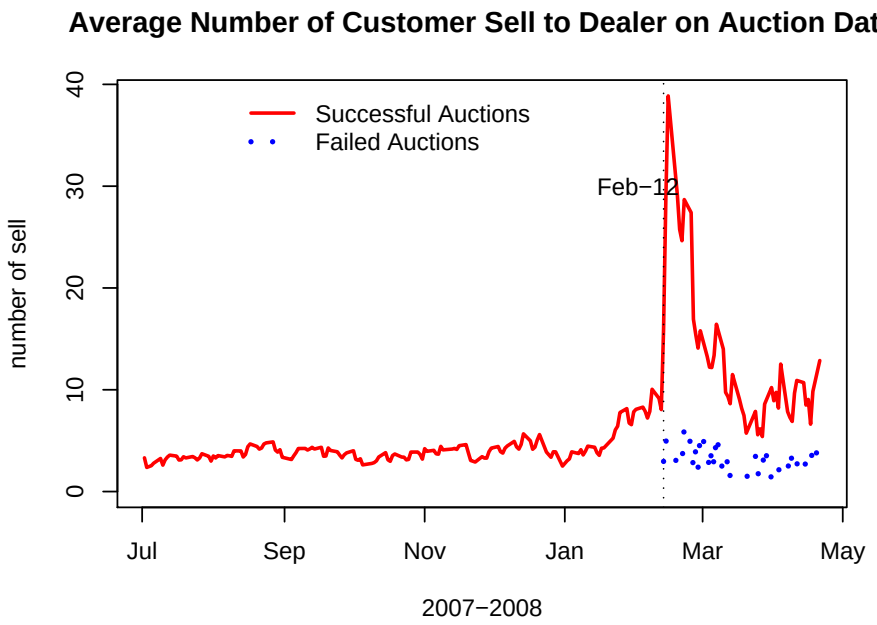


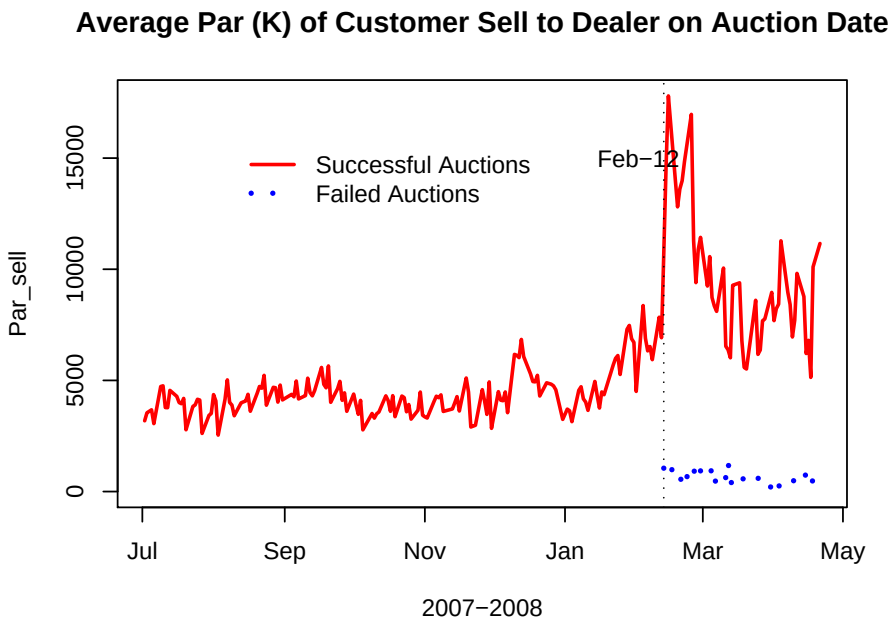
Results from Logit Estimations for Auction Failures

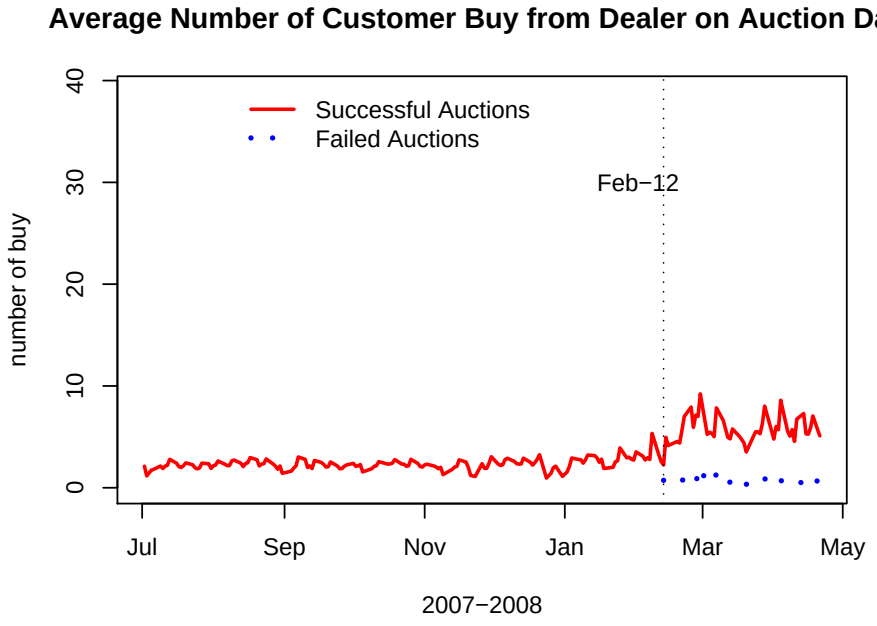
	Pseudo-failure 7/1/07-12/31/07		Actual failure 2/20/08-3/19/08	
Independent var.	(1)	(4)	(6)	(9)
Fixed Max Rate		-0.365		-6.361***
		(0.30)		(1.47)
Fixed Max * Max Rate		0.039*		-0.124
		(0.02)		(0.09)
Floating Max * Max Rate		-0.004		-0.399***
		(0.02)		(0.15)
Controls: bond/credit/macro/2nd	yes	yes	yes	yes
Pseudo-R^2	0.02	0.03	0.27	0.76

Runs for Liquidity in the Week of February 11

- Runs: unusually large number of sell orders, or number of buy orders falls substantially below usual levels
- Orders placed in auction not observable
- Number of sell orders can be reasonably estimated using executed trades on auction dates reported to RTRS
  - Hold-at-rate orders are both a sell and a buy, no impact on auction clearing status
  - In successful auctions, both hold-at-rate and sell orders are all filled
  - In failed auctions, unconditional sell orders filled pro rata in failed auction
- But cannot estimate amount of sell orders, nor number and amount of buy orders


Average Number of Customer Sell to Dealer on Auction Date
number of sell
0
10
20
30
40
Successful Auctions
Failed Auctions
Feb−12
Jul
Sep
Nov
Jan
Mar
May
2007−2008


Average Par (K) of Customer Sell to Dealer on Auction Date
Par_sell
0
5000
10000
15000
Successful Auctions
Failed Auctions
Feb−12
Jul
Sep
Nov
Jan
Mar
May
2007−2008


Average Number of Customer Buy from Dealer on Auction Date
number of buy
0
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20
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Successful Auctions
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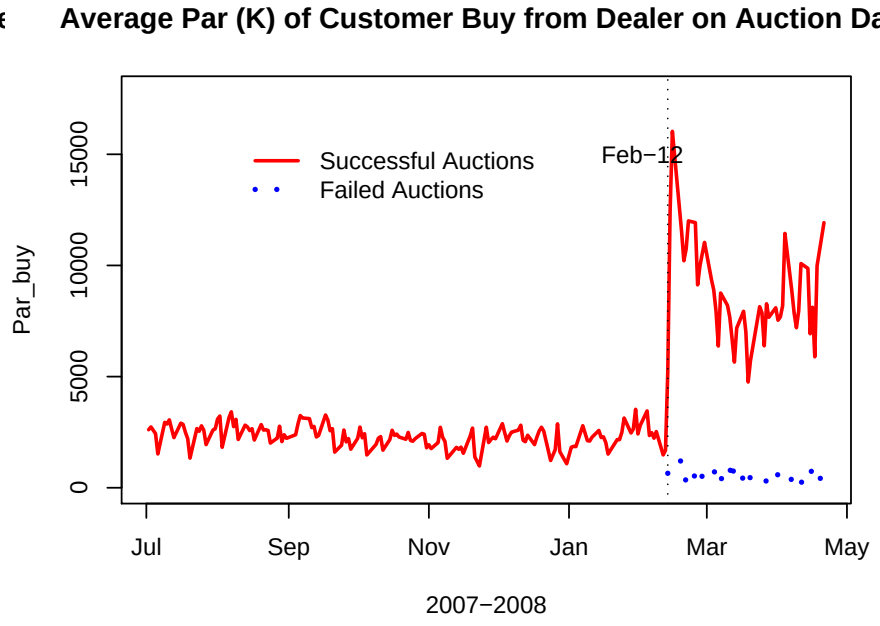
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Par_buy
0
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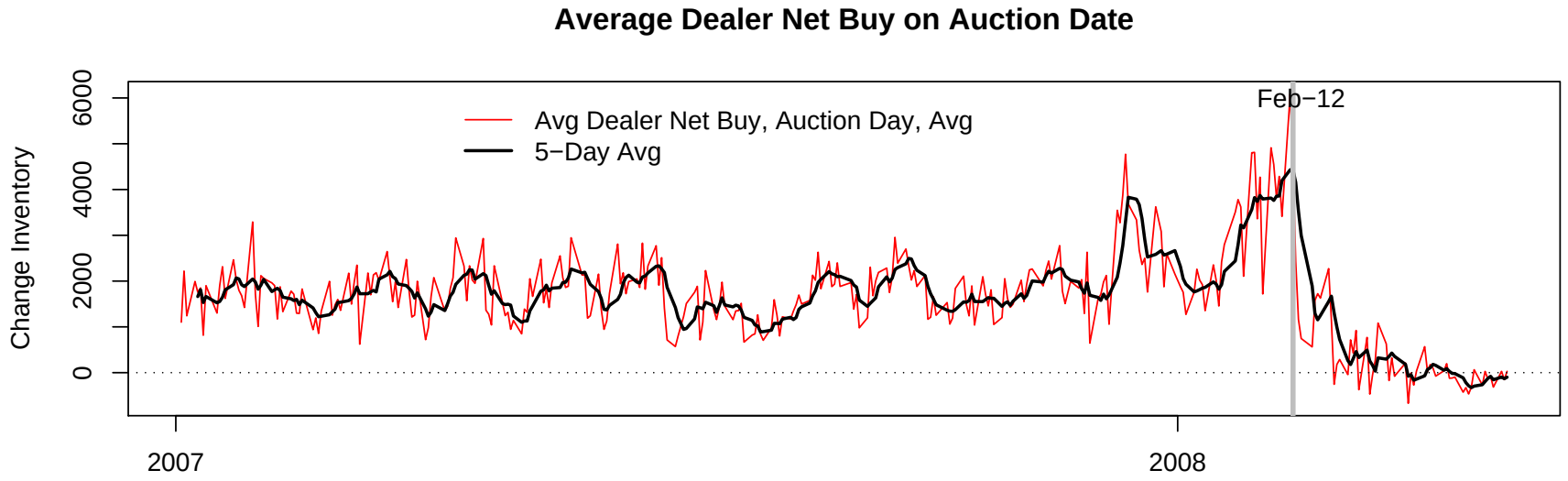
2007−2008

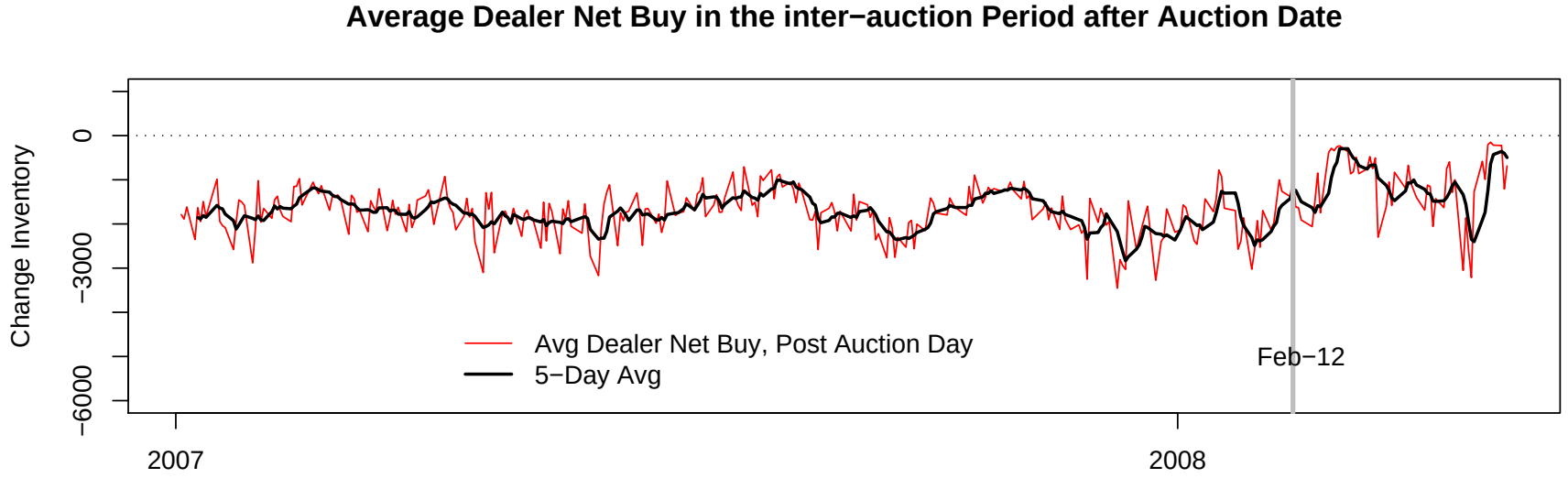
Abnormal Failure Rates in Mid-February

- Predicted failure prob. based on post-crisis model: $\hat{p}_{it} = E(\mathbf{I}_{it}|X_{it}) = 1 - \Phi(\hat{\beta}X_{it})$
- Abnormal failure rate for bond i at t: $p^{\star}_{it} = \mathbf{I}_{it} - \hat{p}_{it}$.
- Observed failure rate: $\overline{p}_t = \frac{\sum_i \mathbf{I}_{it}}{N_t}$
- Predicted failure rate: $\overline{\hat{p}}_t = \frac{\sum_i \hat{p}_{it}}{N_t}$
- Average abnormal failure rate: $\overline{p^{\star}}_t = \frac{\sum_i p^{\star}_{it}}{N_t}$.

Date	$\overline{p}_t$	$\overline{\hat{p}}_t$	$\overline{p^{\star}}_t$	Std. Dev. of $p^{\star}_{it}$	N_t	t-Stat of $\overline{p^{\star}}_t$
2/11/2008	0.04	0.42	-0.40	0.44	225	-13.64
2/12/2008	0.13	0.39	-0.28	0.51	358	-10.45
2/13/2008	0.60	0.43	0.11	0.48	385	4.49
2/14/2008	0.57	0.43	0.09	0.37	309	4.04
2/15/2008	0.57	0.38	0.11	0.32	359	6.79
2/19/2008	0.53	0.45	0.01	0.32	403	0.83

Broker-Dealers as Market Makers





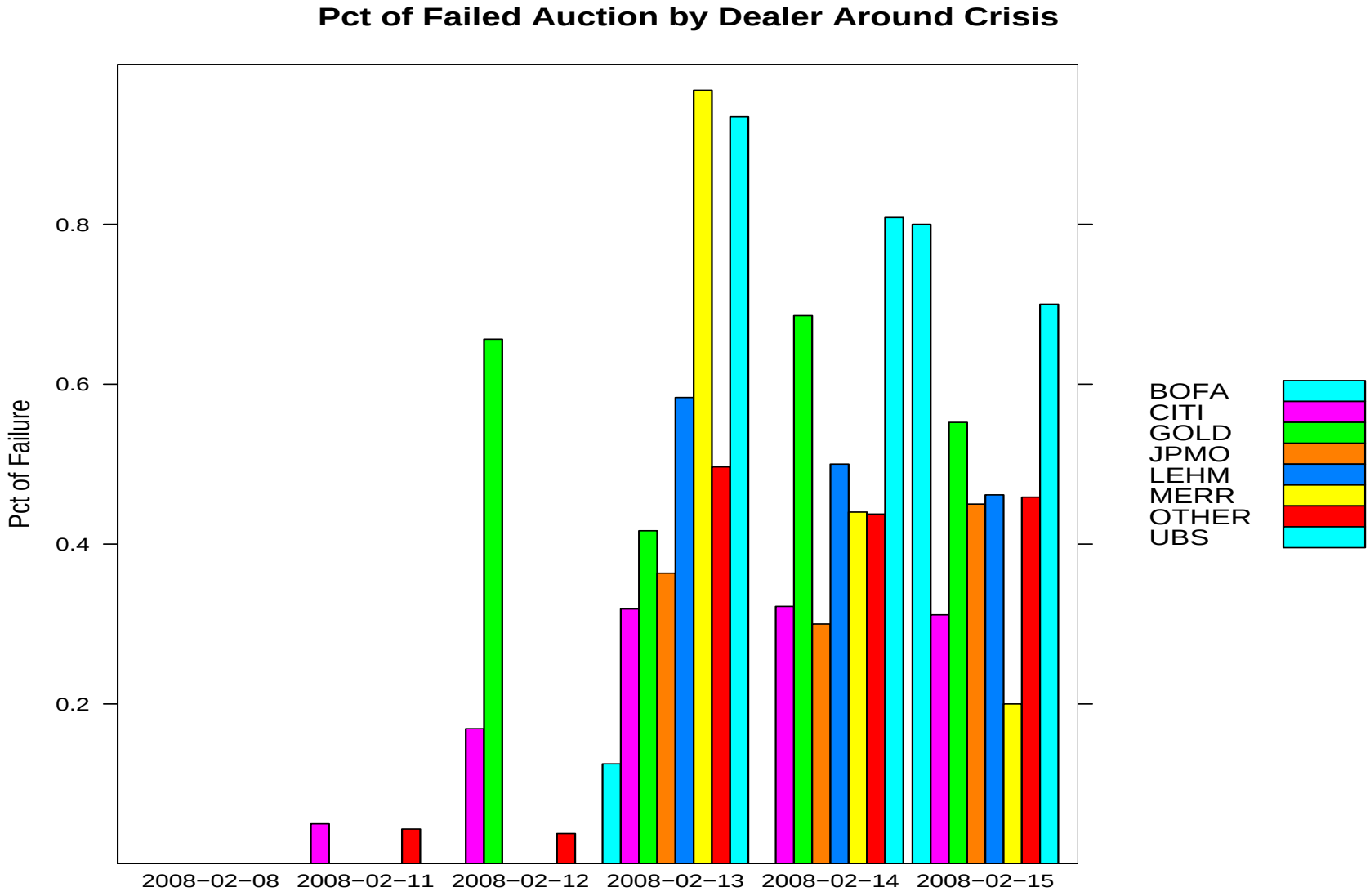
What Caused Almost Simultaneous Withdraw of Liquidity Support?

Possible causes:

- Required capital too large or too costly
- Reputation externality
  - An old Chinese saying: "the law cannot be imposed on the mass"
  - The corollary: being the first one is bad

    David Shulman of UBS described a "worse case" scenario as "contagion and reputational risk of UBS becoming first to fail and breaking the moral obligation to support these markets in an orderly fashion." Moreover, he further proposed to "continue to support all auctions" and "if we do fail—be the 2^{nd} to fail" (January 13, 2008, Exhibit 1, MA AG Investigation).
- Coordination failure among dealers
- Self-fulfilling panic

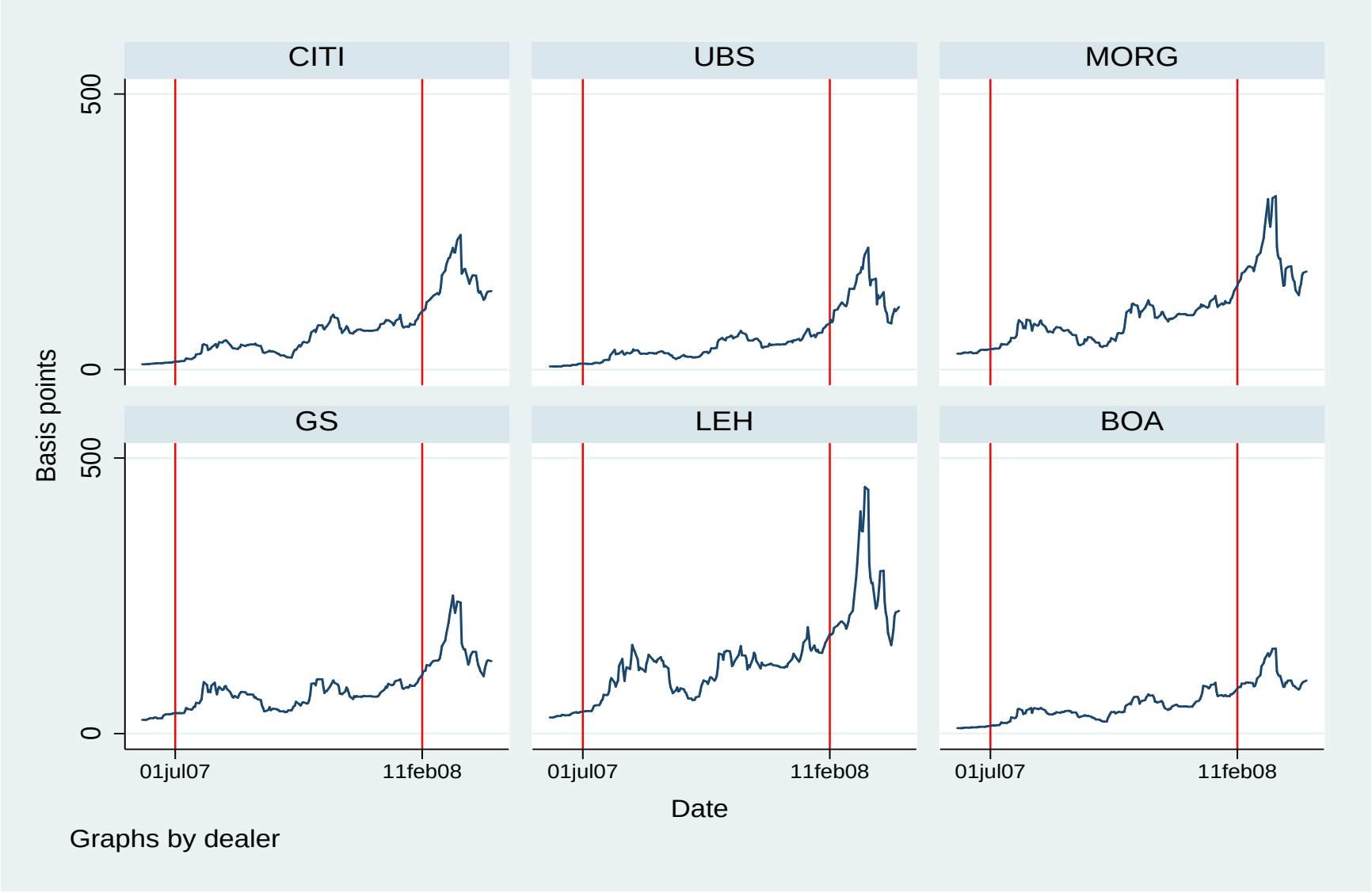
Goldman: the Unexpected First Mover



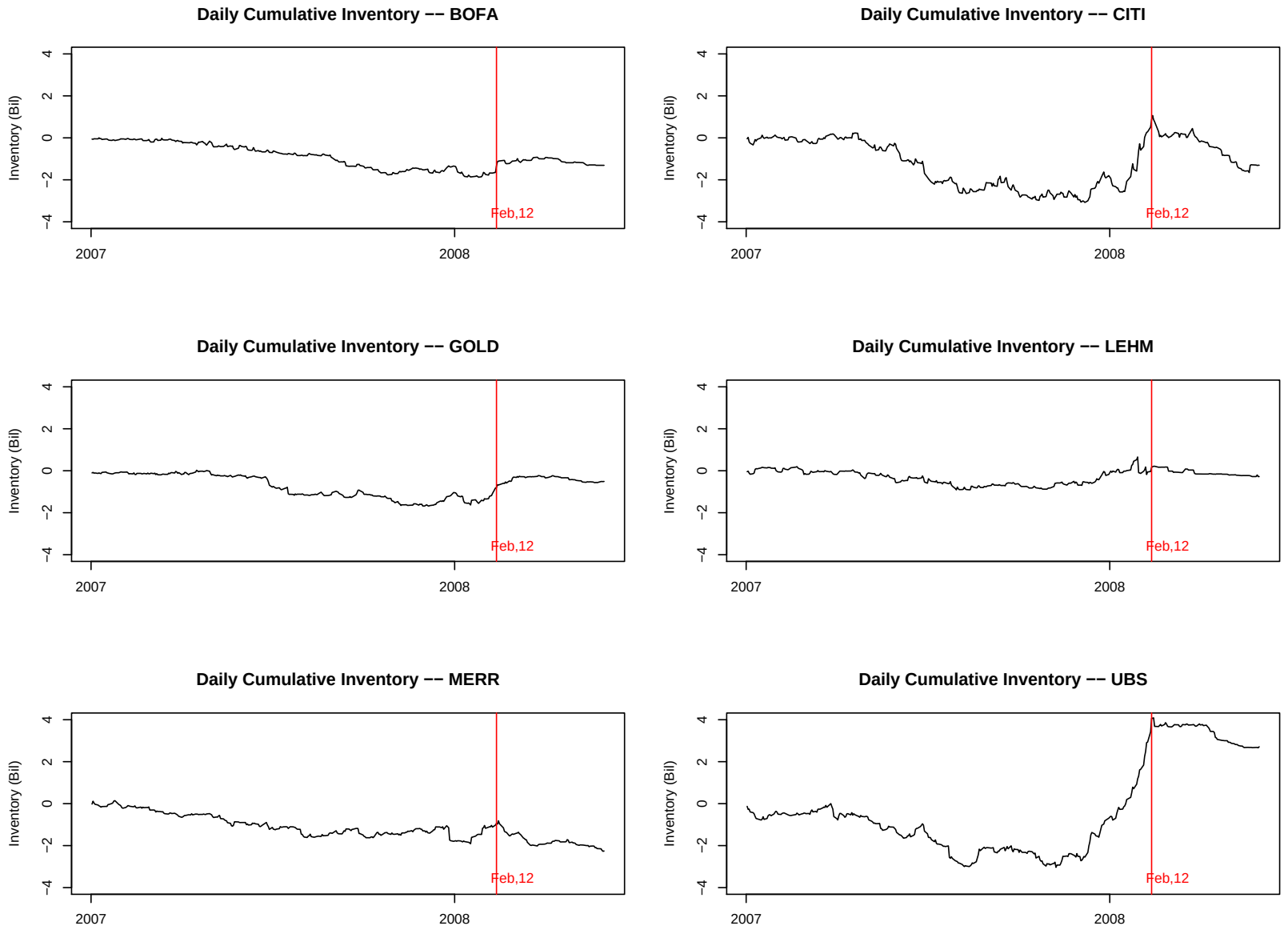
Market Shares of Major Broker-Dealers

Broker-dealer	N. of bonds	Market share (%)
Citigroup	762	21.6
UBS	648	18.4
Morgan Stanley	356	10.1
Goldman Sachs	241	6.8
Lehman Brothers	192	5.5
Bank of America	174	4.9

Costs of Funds of Major Dealers as Measured by CDS Spreads



Changes in Major Broker-Dealers' Inventories



Hypotheses on Auction Reset Rates

- H1: In the post-crisis equilibrium:
  - reset rates are weakly related to bonds' fundamentals;
  - reset rates are positively related to maximum rate;
  - there exists underpricing.
- H2: In the pre-crisis equilibrium:
  - reset rates reflect strongly fundamentals;
  - auction variables such as the maximum rate are not relevant;
  - dealers play an active role in pricing, and they may use prices to manage their inventories.
- H3: Reset rates in the post-crisis equilibrium are increasing in the secondary market liquidity.

Results from OLS Regressions of Reset Rates

	7/1/07-12/31/07		2/20/08-3/19/08	
Independent var.	(1)	(5)	(6)	(10)
Fixed Max Rate		0.088		4.236***
		(0.12)		(1.10)
Fixed Max * Max Rate		0.014*		0.094**
		(0.01)		(0.04)
Float Max * Max Rate		0.029***		0.597***
		(0.01)		(0.14)
Lag Dealer Inventory		0.000***		0.000**
		(0.00)		(0.00)
Inter-auction Trade Freq.		-0.012		0.608***
		(0.01)		(0.10)
Controls: bond, credit, macro	yes	yes	yes	yes
Pseudo-R^2	0.71	0.68	0.20	0.30

Evidence of Underpricing

- Compute predicted reset rates, $\hat{R}_{it}$, for successful auctions from 2/20/08 to 3/19/08 using the pre-crisis model
- Measure for underpricing, $R^{\star}_{it} = R_{it} - \hat{R}_{it}$

	N_t	Mean	Std. Dev.	Min	Max	t-Statistic
Observed Rate, R_{it}	3670	7.43	2.19	0.76	17.00	205.05
Predicted Rate, $\hat{R}_{it}$	3338	3.78	0.40	3.18	5.66	549.70
Underpricing, $R^{\star}_{it}$	3339	3.70	2.16	-3.26	11.72	98.92

Conclusions

Key findings:

- During the ARS crisis, a "bank-run" type behavior occurred
- A significant portion of the auction failures cannot be explained by fundamentals
- An unexpected first mover triggered an equilibrium of coordination failure
- There is strong evidence for underpricing after dealers withdrew liquidity support
  - Reset rates only weakly related to fundamentals,
  - positively related to maximum rate,
  - higher for bonds with fixed maximum rates,
  - positively related to inter-auction secondary market liquidity

Lessons from the MARS Market

- The Fragility of Liquidity
- Market turmoil is the ultimate test on large-scaled financial innovations
  - Design of ARS is fundamentally flawed
  - The evolutionary process leads to more resilient market